TACTICAL SCAN AND LOSS OF SITUATION AWARENESS

A brief prepared for the Human Factors QMB

CDR ANDREW H. BELLENKES
Force Aviation Human Factors Safety Officer
Commander, Naval Air Force
U.S. Atlantic Fleet

What is Situation Awareness (SA)?

***SA*: An attention-based phenomenon reflecting the state of a pilot's awareness based on:**

(1) the *perception & cognition* of *information* relat the 3-dimensional spatial world in and about the a and the hazards associated with that environment (2) the *systems* (especially those that are automa onboard the aircraft itself
(3) the nature of the *tasks* at hand.

The extent and accuracy of this information is a function of what has been (or not been) attended t by the pilot over time. This information is then us (or not) to dictate pilot actions.

VISUAL ATTENTION & SITUATION AWARENESS

Types of SA

SPATIAL

HAZARD

TEMPORAL

MODE

TASK/PROCEDURAL

Causes for Visual SA Problems

Pilot unable to perceive SA-critical elements:

- **obstructed from view**
- **not available on cockpit displays/other navaids.**

Illusions

Data masked by other tasks/attention-catching stimuli:

- information available, but a failure at data sampling due to distractions or fixation on other indicators.

- common in high workload environments.

- Visual dominance may preclude pilot from hearing warning (L-1011 Florida Everglades crash).

Inadequate/ineffective training:

- Created own strategies

- Training failed to transfer

PRINCIPLES OF SCAN AND SITUATION AWARENESS

Tactical visual scan: **a sequential monitoring task where a pilot combines the data gained from each separate outside and cockpit instrument fixation into a full representation of aircraft state (*situation awareness*).**

Pilots quickly create scan and fixation patterns for each different required maneuver (i.e., transition through heading and altitude, takeoff, landing, ACM, CSAR, etc.).

Scan characteristics **(pattern, frequency and duration of fixations): determined by the intrinsic nature, complexity, and importance of the information provided by inside/outside visual targets, and pilot expertise.**

PRINCIPLES OF SCAN AND SITUATION AWARENESS (con

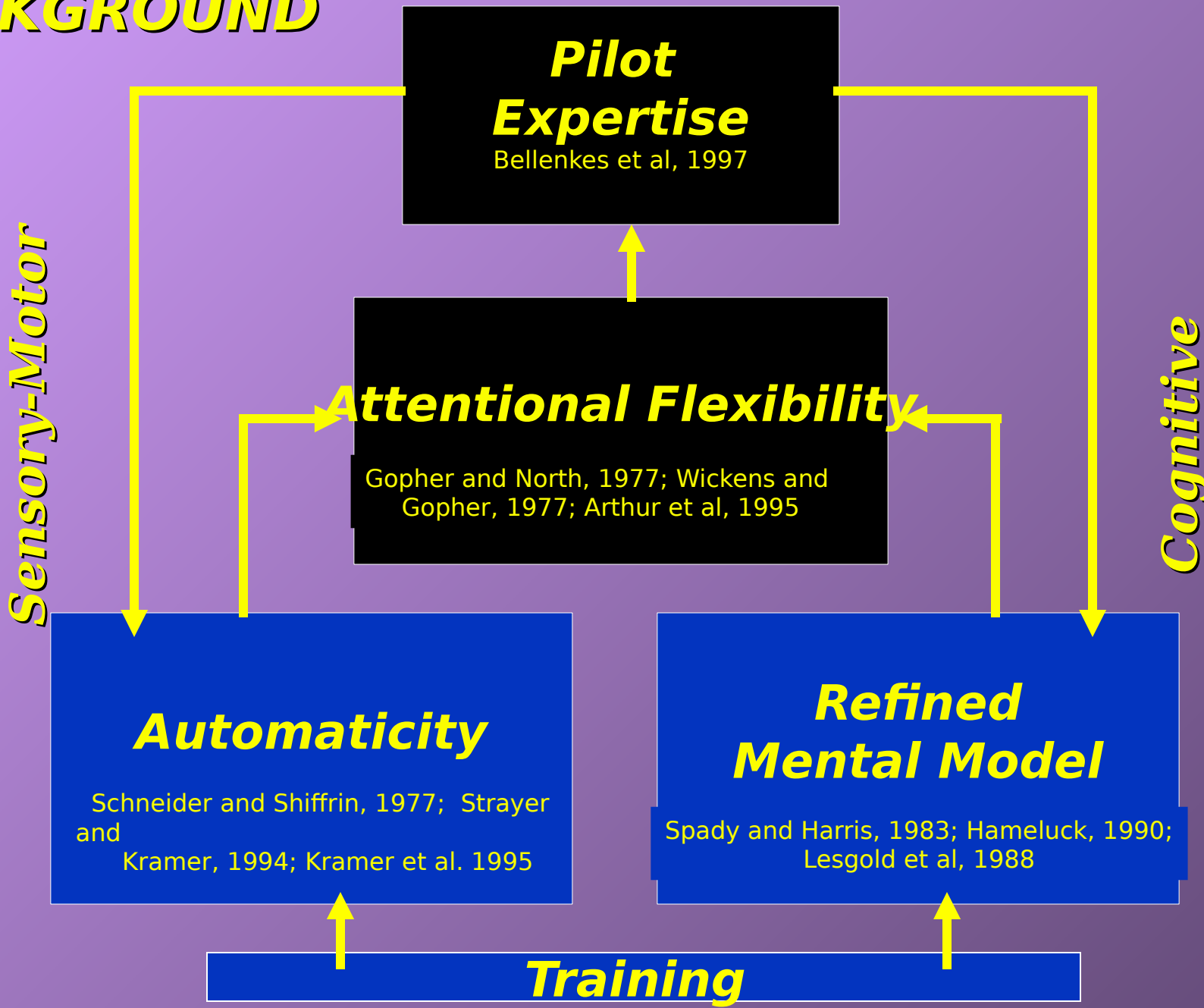
Fixation length (dwell duration) reflects the ability of each pilot to observe and interpret the information from a given target (i.e., longer dwells indicate less ability).

The **number of visits** to a target (frequency of fixations) is a function of how critical that target is perceived to be.

Visual scan favors those targets considered most critical for the performance of a maneuver at the expense of those considered less important.

Scan patterns and fixations may reflect a strategy based on what a pilot (thinks he/she) needs to know at a given time.

BACKGROUND


Pilot Expertise
Bellenkes et al, 1997
Attentional Flexibility
Gopher and North, 1977; Wickens and Gopher, 1977; Arthur et al, 1995
Sensory-Motor
Cognitive
Automaticity
Schneider and Shiffrin, 1977; Strayer and Kramer, 1994; Kramer et al. 1995
Refined Mental Model
Spady and Harris, 1983; Hameluck, 1990; Lesgold et al, 1988
Training

Visual Targets Compete for a Pilot's Attention

The optimal pilot, might balance the gains and costs in sampling certain data while neglecting others; the cost which may be worth incurring to get the information nee

Pilots employing non-optimal scan strategies may fixate scan inappropriately, thereby missing important informa that can result in high cost both to aircraft and crew.

CARRIER LANDING SCAN

TURNING ON FINAL

Abeam
Upwind
Downwind
Turning on Final
Call the Ball
In the Groove
On Deck

Use of image with permission of Peter Inglis from
http://www.migman.com.au/sims/FA18Korea/Carrier2.htm

Navy/Marine Corps Scan-Related Mishaps, FY 1990-99

APPROXIMATELY 60 REPORTS OF SCAN PROBLEMS AS A CONTRIBUTING FACTOR TO A MISHAP/HAZREP.

Tactical: Night Carrier Landing ramp strike and off-center landing with other a/c hit, CFIT

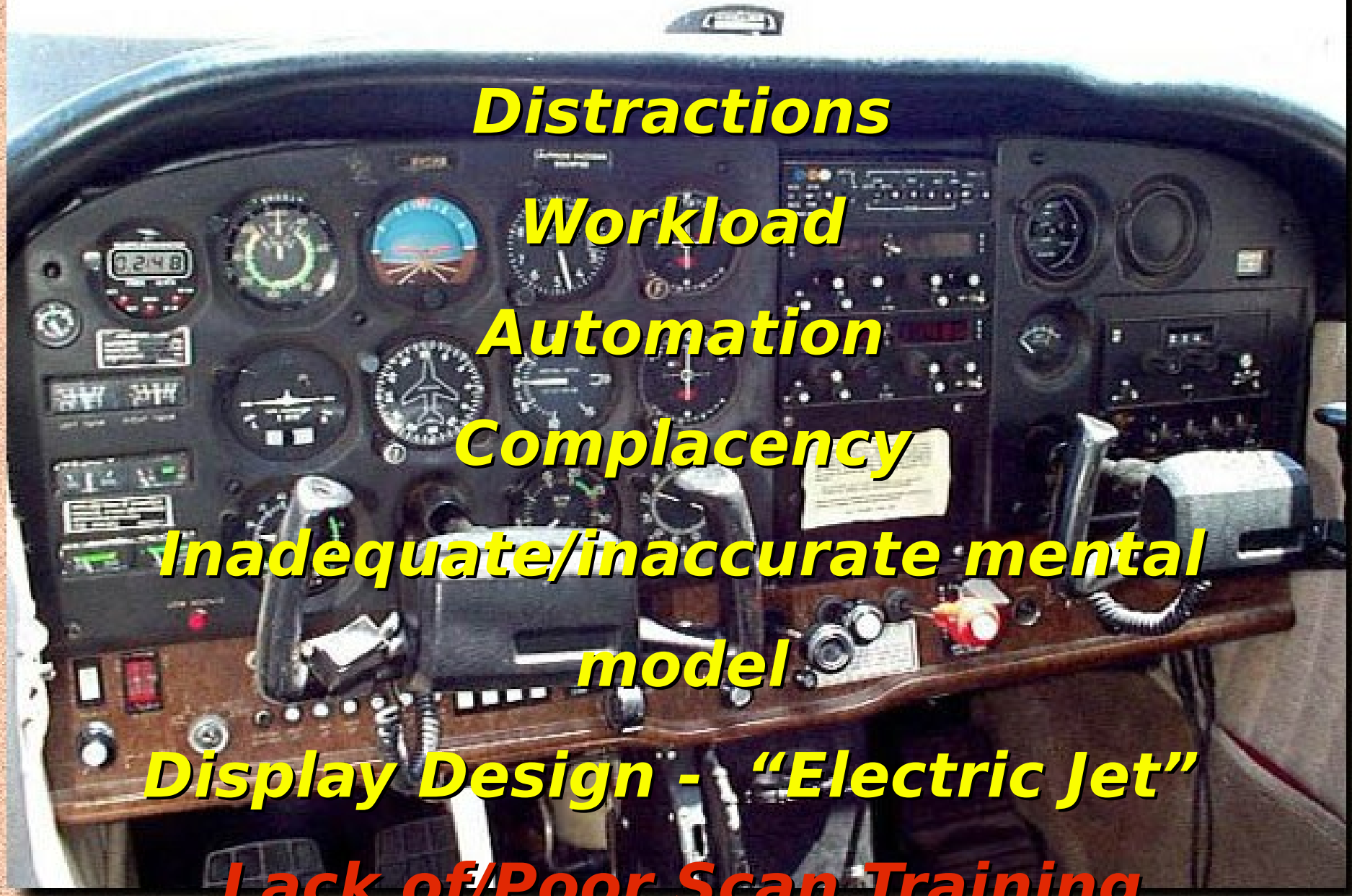
Helo: Blade strike, CFIT

All: Near mid-airs

****(FNAEBS - approx. 40-50% report scan problems)***

From Naval Safety Center Narratives

What Causes Scan to 'Breakdown'?



Distractions

Workload

Automation

Complacency

Inadequate/inaccurate mental model

Display Design - "Electric Jet"

Lack of/Poor Scan Training

How is Scan Currently Taught?

There is a remarkable lack of standardized syllabi associated with teaching tactical visual scan.

Guided training: **students are told where and when to scan targets. 'Chasing' the target rather than controlling the aircraft. Fixating on specific targets.**

The Problem: **Instructor unable to confirm whether or not the pilot is actually scanning effectively. Assumes that if the aircraft is not where it should be at a given point in time, then the pilot has not correctly controlled the aircraft due, in part, to the use of ineffective scan and crosscheck techniques.**

How Should Scan Be Taught?

TOP-DOWN → Standardized didactics
Ensure adequate MM
Guided Training

VS

BOTTOM-UP → Guided Training
No MM check
Drive scan to target

Evidence supports use of Top-Down training

Visual Attention Training Program: Top-Down Tasks

1. Ensure accurate Mental Model foundation
2. Provide standardized syllabus - Didactic & ‘han
3. Monitor scan using oculometer
4. Constant immediate feedback

A Better Way:
STANDARDIZED SCAN TRAINING

HOW ADMINISTERED:

Guided Training
Part of CPT Syllabus
Performance Scored
Part of Training Record

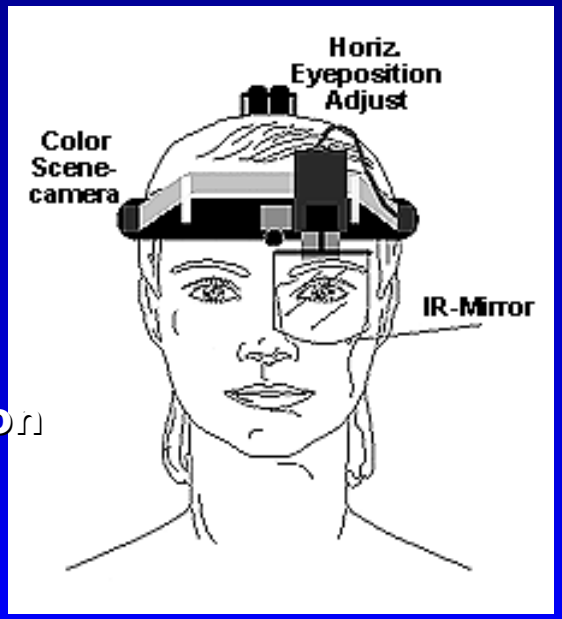
WHEN GIVEN:

Basic Flight Training
Periodic Experienced Pilot Refresher
Aircraft Type Transition

BENEFITS:

Not Subjective/Intuitive
Standardized
Real-Time
Immediate Feedback
Cost-Effective

VIDEO OCULOGRAPHY

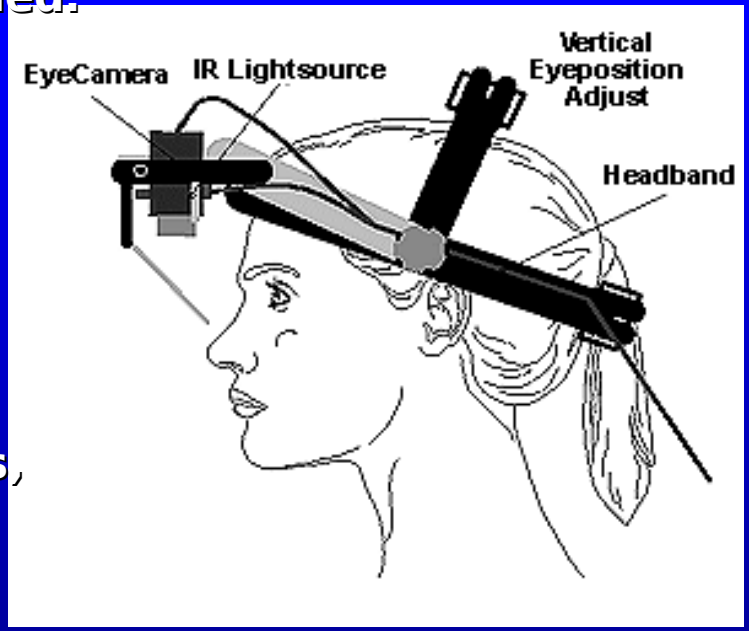


How it Works:

Eye is imaged using infra-red cameras located on head/helmet-close to pilot's eyes.

The image is then scanned by computer.

Real-time visual display feedback provided.



Requirements:

Head movement not restricted

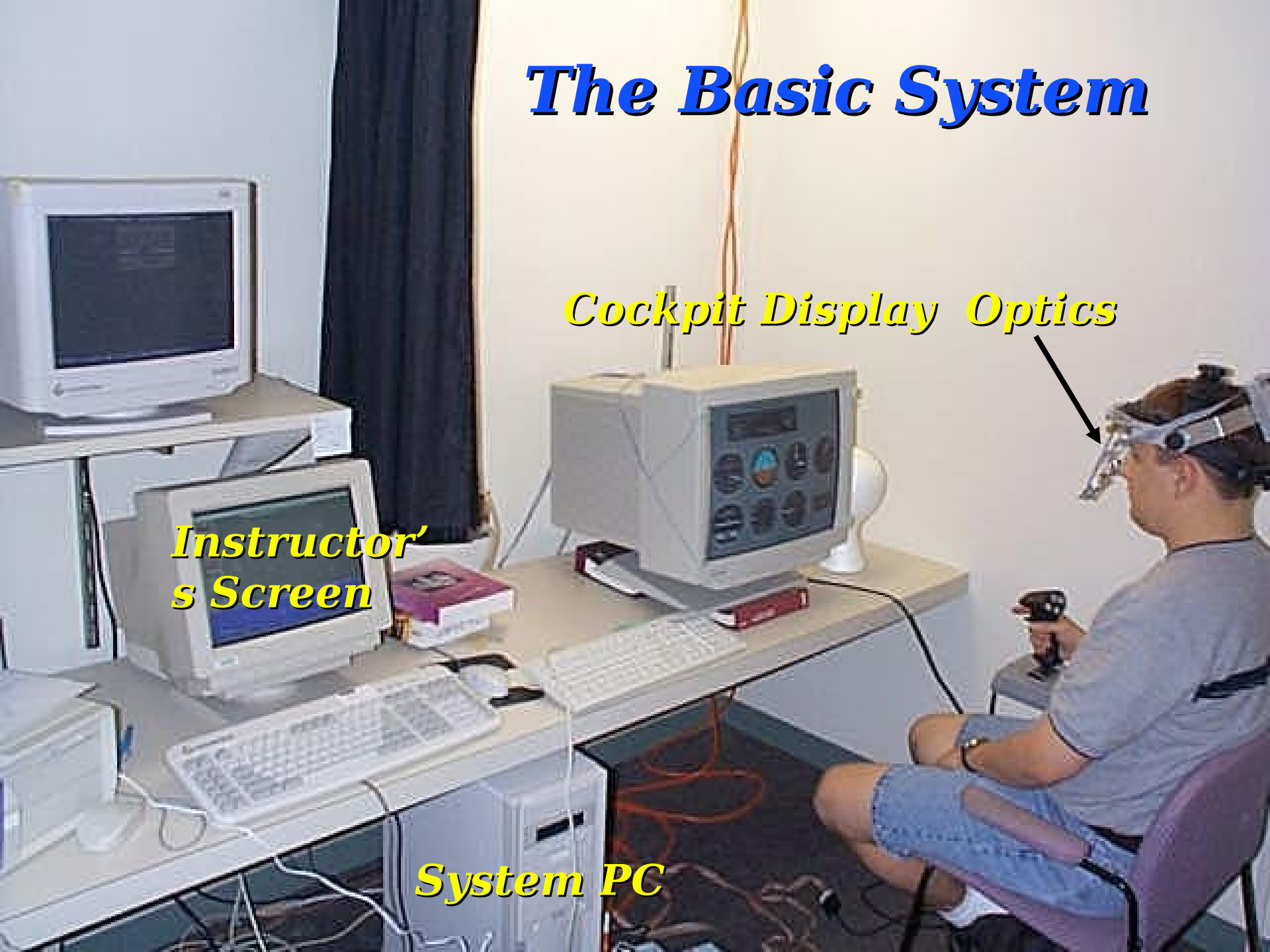
Gear Unobtrusive

Lightweight and Comfortable

Can be operated w/pilot wearing glasses, contacts, helmets or HMDs

•Ref: Woods, D. (1999) METHODS OF MONITORING EYE-MOVEMENTS, http://www.mpi.nl/world/tg/eye-tracking/eye-tracking.html http://www.uwcm.ac.uk/uwcm/dr/groups/vision/em/methods.html

The Basic System



SCAN TRAINING PROGRAM PHASES

A. DEVELOPMENT PHASE: DESIGN PROGRAM

1. **Create training protocol**
2. **Identify best oculographic system for training**
   - benchmark
3. **Purchase/Lease/Borrow system(s) for testing**

B. TEST PHASE : TRAINING COMMANDS

1. **Provide instructor training**
2. **Initial student trials - longitudinal study**
3. **Personnel requirements: Trainer/monitor,**
   System architect/programme

C. IMPLEMENTATION

Benchmarking to Date:

University of Illinois
Aviation Research Laboratory
Beckman Institute

Chris Wickens, Ph.D. **Art Kramer, Ph.D.**

Air Force Research Laboratory
Warfighter Training Research Division
Williams AFB[1]

Virginia Commonwealth Univ.[2]

[1] **Byron J. Pierce, Ph.D.** [2] **Paul Wetzel, Ph.D.**

QUESTIONS?